3GPP TSG-RAN WG4 Meeting #108bis R4-2317250

Xiamen, China, October 09 – October 13, 2023

**Agenda item:** 5.6.5

**Source:** Moderator (Xiaomi)

**Title:** Topic summary for [108bis][126]FR2\_enh\_req\_Ph3\_part2

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this email discussion (e.g. list of treated agenda items) and provide some guidelines for email discussion if necessary.*

The contributions for the following agenda items are summarised in this document:

5.6.2 UL 256QAM

# Topic #1: MPR and PTRS

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2315054**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_108bis/Docs/R4-2315054.zip) | Qualcomm Incorporated | **Observation 1: MPR projections for 256QAM can be very sensitive to estimates of impairment floors from multiple mechanisms in the Tx chain of the UE.****Observation 2: With implementation-grade assumptions for a UE limited to 23 dBm TRP, the additional MPR for 256QAM over that of 64 QAM is 3 dB or less.****Observation 3: With implementation-grade assumptions for a UE limited to 35 dBm, the additional MPR for 256QAM over that of 64 QAM can be conservatively considered to be 3 dB or less.****Proposal 1: The single CC MPR for both PC1 and PC5 in 256QAM operation shall not exceed that of 64QAM by more than 3 dB.** **Proposal 2: Intra-band CA MPRs for both, contig. and NC, and for both PC1 and PC5 in 256QAM operation are increased from their respective 64QAM values by 3 dB as shown in table below:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Contig. and NC CA, PC1 and PC5, MPR (dB) |  | < 400 | < 800 | < 1400 | < 2400 |
| DFT-s | 64 QAM | 9 | 10.7 | 11.2 | 11.7 |
|  | 256 QAM | 9+3 | 10.7+3 | 11.2+3 | 11.7+3 |
|  |  |  |  |  |  |
| CP- | 64 QAM | 9 | 10.7 | 11.2 | 11.7 |
|  | 256 QAM | 9+3 | 10.7+3 | 11.2+3 | 11.7+3 |

**Observation 4: No special treatment is necessary for inter-band CA MPRs for UL256QAM.****Observation 5: No special treatment is necessary for UL MIMO MPRs for UL256QAM.** |
| [**R4-2315265**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_108bis/Docs/R4-2315265.zip) | Nokia, Nokia Shanghai Bell | **Table 1. MPR simulation results for 256QAM with PC1 at 29 GHz.**

|  |  |  |
| --- | --- | --- |
|  |  | **Required back-off [dB]** |
| **Waveform** | **SCS[kHz]** | **Channel bandwidth [MHz]** | **Max** |
| **50** | **100** | **200** | **400** |
| **CP-OFDM** | **60** | 8.8 | 8.8 | 8.9 |  | **8.9** |
| **120** | 8.7 | 8.7 | 8.6 | 8.7 |

**Table 2. MPR simulation results for 256QAM with PC2 at 29 GHz.**

|  |  |  |
| --- | --- | --- |
|  |  | **Required back-off [dB]** |
| **Waveform** | **SCS[kHz]** | **Channel bandwidth [MHz]** | **Max** |
| **50** | **100** | **200** | **400** |
| **CP-OFDM** | **60** | 8.9 | 8.9 | 8.8 |  | **8.9** |
| **120** | 8.7 | 8.8 | 8.8 | 8.8 |

**Table 3. MPR simulation results for 256QAM with PC5 at 29 GHz.**

|  |  |  |
| --- | --- | --- |
|  |  | **Required back-off [dB]** |
| **Waveform** | **SCS[kHz]** | **Channel bandwidth [MHz]** | **Max** |
| **50** | **100** | **200** | **400** |
| **CP-OFDM** | **60** | 8.9 | 8.9 | 8.9 |  | **8.9** |
| **120** | 8.7 | 8.7 | 8.8 | 8.9 |

**Table 4. EVM budget for CP-OFDM at 29 GHz. RB start position 0, number of RBs 64, SCS 120 kHz.**

|  |  |
| --- | --- |
| Tx EVM contributor | **EVM (%)** |
| Phase Noise+IQ Imbalance | 2.81 |
| PA Non-linearity & Transmitter | 2.09 |
| Total | 3.50 |

**Table 5. Contribution of phase noise to EVM at 39 GHz. RB start position 0, number of RBs 64, SCS 120 kHz. PTRS was not used.**

|  |  |  |
| --- | --- | --- |
| waveform | **EVM (%)** | **EVM (dB)** |
| DFT-s-OFDM | 3.26 | -29.74 |
| CP-OFDM | 3.27 | -29.71 |

 |
| [**R4-2315266**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_108bis/Docs/R4-2315266.zip) | Nokia, Nokia Shanghai Bell | **Proposal 1: To specify the MRP requirements for 256QAM UL by averaging the MPR simulation results from different companies.****Proposal 2: To further discuss the phase noise model at 39 GHz before deciding how to define the MPR requirements for 39GHz.** |
| [**R4-2315437**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_108bis/Docs/R4-2315437.zip) | Xiaomi | **Proposal 1: Based on current regions definition of RB allocations, the MPR of UL 256 QAM for 29GHz could be**

|  |  |
| --- | --- |
| Modulation | MPRWT (dB), BWchannel ≤ 200 MHz |
|  | Outer RB allocations | Inner RB allocations |
|  |  | Region 1 | Region 2 |
| DFT-s-OFDM | 256QAM | 9 | 9 | 9 |
| CP-OFDM | 11 | 11 | 11 |

|  |  |
| --- | --- |
| Modulation | MPRWT (dB), BWchannel = 400 MHz |
|  | Outer RB allocations | Inner RB allocations |
|  |  | Region 1 | Region 2 |
| DFT-s-OFDM | 256QAM | 9 | 9 | 9 |
| CP-OFDM | 11 | 11 | 11 |

**Proposal 2: The MPR of UL 256 QAM for 39GHz could be the same as the values of 29GHz.****Proposal 3: Remove PC3 from the object of FR2-1 UL 256QAM in the WID.****Proposal 4: How to capture the MPR of 256QAM for PC2/5:*** **Option1: Capture into the MPR table of PC3 and clarify that MPRs for 256QAM are applicable for power class 2 and 5 only in the note, as below:**

|  |  |
| --- | --- |
| Modulation | MPRWT, BWchannel |
|  | Inner RB allocations,Region 1 | Edge RB allocations |
| DFT-s-OFDM | Pi/2 BPSK | 0.0 | ≤ 2.0 |
|  | QPSK | 0.0 | ≤ 2.0 |
|  | 16 QAM | ≤ 3.0 | ≤ 3.5 |
|  | 64 QAM | ≤ 5.0 | ≤ 5.5 |
|  | 256 QAM | TBD | TBD |
| CP-OFDM | QPSK | ≤ 3.5 | ≤ 4.0 |
|  | 16 QAM | ≤ 5.0 | ≤ 5.0 |
|  | 64 QAM | ≤ 7.5 | ≤ 7.5 |
|  | 256 QAM | TBD | TBD |
| Note 1: MPRs for 256QAM are applicable for power class 2 and 5 only. |

* **Option2: introduce a new table into related clause of PC2 6.2.2.2 for 256QAM:**

|  |  |
| --- | --- |
| Modulation | MPRWT, BWchannel |
|  | Inner RB allocations,Region 1 | Edge RB allocations |
| DFT-s-OFDM | 256 QAM | TBD | TBD |
| CP-OFDM | 256 QAM | TBD | TBD |

 |
| [**R4-2315540**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_108bis/Docs/R4-2315540.zip) | LG Electronics France | ***Observation 1*:** The lower MPR value with low AM-PM distortion PA than MPR value with general PA is observed.**Proposal 1**: Suggest the MPR value for FR2-1 UL256QAM PC1. (29 GHz: Table 6, 39 GHz: Table 7)Table 6 The proposed MPR values for 29 GHz PC1 UL256QAM

|  |  |  |  |
| --- | --- | --- | --- |
| **CBW****(100 MHz)** | **Region 1** | **Region 2** | **Outer** |
| **DFT-s-OFDM** | 8.5 | 8 | 8.5 |
| **CP-OFDM** | 10.5 | 10.5 | 10.5 |
| **CBW****(400 MHz)** | **Region 1** | **Region 2** | Outer |
| **DFT-s-OFDM** | 9.5 | 9.5 | 10 |
| **CP-OFDM** | 12 | 12.5 | 12 |

Table 7 The proposed MPR values for 39 GHz PC1 UL256QAM

|  |  |  |  |
| --- | --- | --- | --- |
| **CBW****(100 MHz)** | **Region 1** | **Region 2** | **Outer** |
| **DFT-s-OFDM** | 8.5 | 8 | 8.5 |
| **CP-OFDM** | 11 | 10.5 | 11 |
| **CBW****(400 MHz)** | **Region 1** | **Region 2** | Outer |
| **DFT-s-OFDM** | 9.5 | 10 | 10.5 |
| **CP-OFDM** | 12 | 12.5 | 13 |

Proposal 2: Need to discuss how to deal with the frequency dependency for FR2-1 UL256QAM. |
| [**R4-2315559**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_108bis/Docs/R4-2315559.zip) | MediaTek (Shenzhen) Inc. | **Observation 1: For MPR requirements without PTRS compensation, both MTK's and Qualcomm's phase noise models are nearly identical. It is sufficient to just use one of these two models for further evaluation.** **Observation 2: MPR requirements for 256QAM are solely determined by the EVM.****Observation 3: MPR values differ between the 29GHz and 39GHz frequency bands due to variations in phase noise performance.****Proposal 1: Based on the simulation results and analysis, we propose the FR2-1 256QAM MPR values for PC1/2/5 as shown in Table 2-5.****Proposal 2: RAN4 to consider a common MPR is defined for all FR2 bands, and then introduce a band-specific Δ value for 39GHz frequency band as shown in Table 6.** |
| [**R4-2315561**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_108bis/Docs/R4-2315561.zip) | Sony | **Observation 1: with the assumption of 18 dBm minimum EIRP, it is possible that no dynamic range is available if the corresponding MPR is more than 12 dB.** **Observation 2 it is no longer feasible to only consider the UE implementation without including the impact analysis on the network performance in FR2 due to the extremely link budget when it comes to MPR requirements.** **Observation 3: It is necessary to cap the MPR value with a reasonable value to guarantee the network performance.** **Observation 4: It is feasible for implementations to meet the proposed confinement range.** **Proposal 1: The MPR of UL 256 QAM needs to be confined so that the UE can reach reasonable EIRP levels and dynamic range in a real network scenario.**Proposal 2: It is proposed that the MPR for UL 256 QAM shall not exceed 3 dB more than 64QAM. **Proposal 3: use the same MPR values for 39 GHz and 28 GHz.****Proposal 4: It is proposed that the MPR for UL 256 QAM shall not exceed 3 dB more than 64QAM for CA as well.**  |
| [**R4-2315563**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_108bis/Docs/R4-2315563.zip) | ZTE Corporation | **Proposal 1: 29GHz PC1 256QAM DFT-s-OFDM and CP-OFDM MPR requirements are proposed:**Table 2-2 MPR requirements for 29GHz PC1 256QAM DFT-s-OFDM and CP-OFDM (BWchannel ≤ 200 MHz)

|  |  |
| --- | --- |
| Modulation | MPRWT (dB), BWchannel ≤ 200 MHz |
|  | Outer RB allocations | Inner RB allocations |
|  |  | Region 1 | Region 2 |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 5.5 | 0.0 | ≤ 3.0 |
|  | QPSK | ≤ 6.5 | 0.0 | ≤ 3.0 |
|  | 16 QAM | ≤ 6.5 | ≤ 4.0 | ≤ 4.0 |
|  | 64 QAM | ≤ 6.5 | ≤ 5.0 | ≤ 5.0 |
|  | 256QAM | ≤7.5 | ≤ 7.5 | ≤ 7.5 |
| CP-OFDM | QPSK | ≤ 7.0 | ≤ 4.5 | ≤ 4.5 |
|  | 16 QAM | ≤ 7.0 | ≤ 5.5 | ≤ 5.5 |
|  | 64 QAM | ≤ 7.5 | ≤ 7.5 | ≤ 7.5 |
|  | 256QAM | ≤ 10.5 | ≤ 10.5 | ≤ 10.5 |

Table 2-3 MPR requirements for 29GHz PC1 256QAM DFT-s-OFDM and CP-OFDM (BWchannel = 400 MHz)

|  |  |
| --- | --- |
| Modulation | MPRWT (dB), BWchannel = 400 MHz |
|  | Outer RB allocations | Inner RB allocations |
|  |  | Region 1 | Region 2 |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 5.5 | 0.0 | ≤ 3.0 |
|  | QPSK | ≤ 6.5 | 0.0 | ≤ 3.5 |
|  | 16 QAM | ≤ 6.5 | ≤ 4.5 | ≤ 4.5 |
|  | 64 QAM | ≤ 6.5 | ≤ 6.5 | ≤ 6.5 |
|  | 256QAM | ≤7.5 | ≤ 7.5 | ≤ 7.5 |
| CP-OFDM | QPSK | ≤ 7.0 | ≤ 5.0 | ≤ 5.0 |
|  | 16 QAM | ≤ 7.0 | ≤ 6.5 | ≤ 6.5 |
|  | 64 QAM | ≤ 9.0 | ≤ 9.0 | ≤ 9.0 |
|  | 256QAM | ≤ 10.5 | ≤ 10.5 | ≤ 10.5 |

 |
| [**R4-2315808**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_108bis/Docs/R4-2315808.zip) | vivo | **Observation 1:** The phase noise is not considered in the modulation order other than 256QAM in FR2.**Observation 2:** The phase noise profile is closely related to the frequency.**Observation 3:** The PTRS is mandatory for FR2 and there is no proper place to capture PTRS configuration agreement in RAN4 spec.**Proposal 1:** The MPR table for FR2 256QAM will be defined based on the assumption without phase noise and introducing △MPR to capture the difference due to phase noise changing along with frequency:Table 6.2.2.1-1 MPRWT for power class 1, BWchannel ≤ 200 MHz

|  |  |
| --- | --- |
| Modulation | MPRWT (dB), BWchannel ≤ 200 MHz |
|  | Outer RB allocations | Inner RB allocations |
|  |  | Region 1 | Region 2 |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 5.5 | 0.0 | ≤ 3.0 |
|  | QPSK | ≤ 6.5 | 0.0 | ≤ 3.0 |
|  | 16 QAM | ≤ 6.5 | ≤ 4.0 | ≤ 4.0 |
|  | 64 QAM | ≤ 6.5 | ≤ 5.0 | ≤ 5.0 |
|  | 256QAM | ≤ 8.0 | ≤ 8.0 | ≤ 8.0 |
| CP-OFDM | QPSK | ≤ 7.0 | ≤ 4.5 | ≤ 4.5 |
|  | 16 QAM | ≤ 7.0 | ≤ 5.5 | ≤ 5.5 |
|  | 64 QAM | ≤ 7.5 | ≤ 7.5 | ≤ 7.5 |
|  | 256QAM | ≤ 11.0 | ≤ 11.0 | ≤ 11.0 |

Table 6.2.2.1-2 MPRWT for power class 1, BWchannel = 400 MHz

|  |  |
| --- | --- |
| Modulation | MPRWT (dB), BWchannel = 400 MHz |
|  | Outer RB allocations | Inner RB allocations |
|  |  | Region 1 | Region 2 |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 5.5 | 0.0 | ≤ 3.0 |
|  | QPSK | ≤ 6.5 | 0.0 | ≤ 3.5 |
|  | 16 QAM | ≤ 6.5 | ≤ 4.5 | ≤ 4.5 |
|  | 64 QAM | ≤ 6.5 | ≤ 6.5 | ≤ 6.5 |
|  | 256QAM | ≤ 9.5 | ≤ 9.5 | ≤ 9.5 |
| CP-OFDM | QPSK | ≤ 7.0 | ≤ 5.0 | ≤ 5.0 |
|  | 16 QAM | ≤ 7.0 | ≤ 6.5 | ≤ 6.5 |
|  | 64 QAM | ≤ 9.0 | ≤ 9.0 | ≤ 9.0 |
|  | 256QAM | ≤ 12.5 | ≤ 12.5 | ≤ 12.5 |

Table 6.2.2.1-3 △MPR for power class 1

|  |  |  |
| --- | --- | --- |
| Modulation | Band  | △MPR (dB) |
|  |  | BWchannel ≤ 200 MHz | BWchannel = 400 MHz |
| DFT-s-OFDM | 256QAM | n257, n258, n261 | 1.0 | 1.0 |
|  | n259, n260 | 3.5 | 3.5 |
| CP-OFDM | 256QAM | n257, n258, n261 | 0.5 | 0.5 |
|  | n259, n260 | 3.0 | 3.0 |

**Proposal 2:** Send a LS to RAN5 to inform that PTRS is not configured for FR2 256QAM related test, e.g., EVM, MPR. |
| [**R4-2315809**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_108bis/Docs/R4-2315809.zip) | vivo | Draft LS to RAN5 to inform that PTRS is not configured for FR2 256QAM related test, e.g., EVM, MPR. |
| [**R4-2316379**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_108bis/Docs/R4-2316379.zip) | Huawei, HiSilicon | **Proposal 1**: MPR for FR2 UL 256QAM:

|  |  |  |
| --- | --- | --- |
| Modulation | Companies | MPRWT (dB), BWchannel ≤ 100 MHz/200MHz |
|  | Outer RB allocations | Inner RB allocations |
|  |  |  | Region 1 | Region 2 |
| DFT-s-OFDM | 64 QAM | - | ≤ 6.5 | ≤ 5.0 | ≤ 5.0 |
|  | 256QAM | Huawei | 9.1 |
| CP-OFDM | 64 QAM | - | ≤ 7.5 | ≤ 7.5 | ≤ 7.5 |

 |
| [**R4-2316789**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_108bis/Docs/R4-2316789.zip) | Apple | **Observation 1:** PC3 is considered for handhelds and features the lowest dynamic range. This would make deployment slightly more challenging compared to the other power classes considered for FWA type devices. Capping the delta MPR to 3dB for PC3 demands high linear FR2 power amplifier featuring considerable current draw and heat generation. The smaller form factor brings challenges to RF, antenna design and heat dissipation. The tight demands on battery consumption limits design choices of the FR2 PA e.g. in terms of maximum current draw.**Observation 2:** It might not be acceptably to increase the allowed power back-off. Therefore, other solutions should be considered such as increasing 256QAM PC3 Tx EVM to 4%. This additional headroom allows the power amplifier to reside in a higher compression and more efficient region resulting into lower power dissipation and heating. Physical area consumption of the amplifier is smaller, and the design challenge does relax. It could be an enabler to allow handhelds the use of 256QAM modulation. This approach would avoid 256QAM being defined in spec but an untouched feature in the field.**Observation 3:** Proposals have already been made in RAN plenary to explore PC3 256QAM in Rel-19. As PC3 has been considered as secondary priority it might be reasonable to shift the completion to Rel-19. **Proposal:** The following items are proposed as a package1. Shift completion of PC3 256QAM to Rel-19 and take the time to discuss the specific challenges on handhelds.
2. Evaluate the impact of 4% Tx EVM on the network performance and PA design challenges. Rx EVM at base station remains at 3.5%.
3. A max delta of 3dB between 64QAM and 256QAM can be acceptable for PC1, PC2 and PC5 if this agreement is not treated as a precedence for PC3 discussion.
 |
| [**R4-2316837**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_108bis/Docs/R4-2316837.zip) | Ericsson Limited, CENC | **Proposal 1: The MPR for UL 256QAM shall be specified in the range of 1dB - 3dB higher than the corresponding value for 64QAM.****Proposal 2: Do not specify different MPR values for different bands in FR2-1.****Observation 1: Given how close the min EIRP for UL 256QAM and the EIRP which passes the minimum peak EIRP test are, the MPR requirements for 256QAM shall be bounded to enable a decent dynamic range for EIRP.** |

## Open issues summary

*Before Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 1-1 MPR requirement

*Sub-topic description*

*Open issues and candidate options before meeting:*

Summary of the simulation results for MPR

29GHz

PC1 MPR simulation results for 29 GHz with 120kHz SCS UL256QAM

|  |  |  |
| --- | --- | --- |
| Modulation | Companies | MPRWT (dB), BWchannel ≤ 100/200 MHz |
|  | Outer RB allocations | Inner RB allocations |
|  |  | Region 1 | Region 2 |
| DFT-s-OFDM | 64 QAM | - | ≤ 6.5 | ≤ 5.0 | ≤ 5.0 |
|  | 256QAM | Xiaomi(R4-2315437) | 9 | 9 | 9 |
|  |  | MediaTek(R4-2315559) | 9 | 9 | 9 |
|  |  | ZTE(R4-2315563) | 7.5 | 7.5 | 7.5 |
|  |  | LGE(R4-2315540) | 8.5 | 8.5 | 8 |
|  |  | vivo(R4-2315808) | 8 | 8 | 8 |
|  |  | Qualcomm(R4-2315054) | 9.5 | 8 | 8 |
|  |  | Huawei(R4-2316379) | 9.1 |
|  |  | Nokia (R4-2311665) | 7.2 |
|  |  | Average | 8.5 | 8.3 | 8.2 |
| CP-OFDM | 64 QAM | - | ≤ 7.5 | ≤ 7.5 | ≤ 7.5 |
|  | 256QAM | Nokia (R4-2315265) | 8.6 |
|  |  | Xiaomi(R4-2315437) | 11 | 11 | 11 |
|  |  | MediaTek(R4-2315559) | 11.5 | 11.5 | 11.5 |
|  |  | ZTE(R4-2315563) | 10.5 | 10.5 | 10.5 |
|  |  | vivo(R4-2315808) | 11 | 11 | 11 |
|  |  | LGE(R4-2315540) | 10.5 | 10.5 | 10.5 |
|  |  | Sony(R4-2315561) | 11.2 | 11.6 | 11.5 |
|  |  | Qualcomm(R4-2315054) | 10.5 | 10.5 | 10.5 |
|  |  | Huawei(R4-2316379) | 11.8 |
|  |  | Average | 10.7 | 10.8 | 10.8 |

|  |  |  |
| --- | --- | --- |
| Modulation | Companies | MPRWT (dB), BWchannel =400 MHz |
|  | Outer RB allocations | Inner RB allocations |
|  |  |  | Region 1 | Region 2 |
| DFT-s-OFDM | 64 QAM |  | ≤ 6.5 | ≤ 6.5 | ≤ 6.5 |
|  | 256QAM | Xiaomi(R4-2315437) | 9 | 9 | 9 |
|  |  | LGE(R4-2315540) | 10 | 9.5 | 9.5 |
|  |  | MediaTek(R4-2315559) | 10.5 | 10.5 | 10.5 |
|  |  | ZTE(R4-2315563) | 7.5 | 7.5 | 7.5 |
|  |  | vivo(R4-2315808) | 9.5 | 9.5 | 9.5 |
|  |  | Nokia (R4-2311665) | 7.2 |
|  |  | Average | 9 | 8.9 | 8.9 |
| CP-OFDM | 64 QAM |  | ≤ 9.0 | ≤ 9.0 | ≤ 9.0 |
|  | 256QAM | Nokia (R4-2315265) | 8.7 |
|  |  | Xiaomi(R4-2315437) | 11 | 11 | 11 |
|  |  | LGE(R4-2315540) | 12 | 12 | 12.5 |
|  |  | MediaTek(R4-2315559) | 13 | 13 | 13 |
|  |  | Sony(R4-2315561) | 12 | 10.7 | 11.3 |
|  |  | ZTE(R4-2315563) | 10.5 | 10.5 | 10.5 |
|  |  | vivo(R4-2315808) | 12.5 | 12.5 | 12.5 |
|  |  | Average | 11.4 | 11.2 | 11.4 |

PC2 MPR results for 29 GHz with 120kHz SCS UL256QAM

|  |  |  |
| --- | --- | --- |
| Modulation | Companies | MPRWT, BWchannel ≤ 100/200 MHz |
|  | Inner RB allocations,Region 1 | Edge RB allocations |
| DFT-s-OFDM | 64 QAM |  | ≤ 5.0 | ≤ 5.5 |
|  | 256QAM | MediaTek(R4-2315559) | 9 | 9 |
|  |  | LGE(R4-2315540) | 8 | 8 |
|  |  | Qualcomm(R4-2315054) | 8 | 8.5 |
|  |  | Nokia (R4-2311665) | 7.1 |
|  |  | Average | 8 | 8.2 |
| CP-OFDM | 64 QAM |  | ≤ 7.5 | ≤ 7.5 |
|  | 256QAM | Nokia (R4-2315265) | 8.8 |
|  |  | MediaTek(R4-2315559) | 11.5 | 11.5 |
|  |  | LGE(R4-2315540) | 10.5 | 10.5 |
|  |  | Qualcomm(R4-2315054) | 10.5 | 10.5 |
|  |  | Average | 10.3 | 10.3 |

|  |  |  |
| --- | --- | --- |
| Modulation | Companies | MPRWT, BWchannel =400 MHz |
|  | Inner RB allocations,Region 1 | Edge RB allocations |
| DFT-s-OFDM | 64 QAM |  | ≤ 6.5 | ≤ 6.5 |
|  | 256QAM | LGE(R4-2315540) | 10 | 9.5 |
|  |  | MediaTek(R4-2315559) | 10.5 | 10.5 |
|  |  | Nokia (R4-2311665) | 7.0 |
|  |  | Average | 9.2 | 9.2 |
| CP-OFDM | 64 QAM |  | ≤ 9 | ≤ 9 |
|  | 256QAM | Nokia (R4-2315265) | 8.8 |
|  |  | LGE(R4-2315540) | 11.5 | 11.5 |
|  |  | MediaTek(R4-2315559) | 13 | 13 |
|  |  | Average | 11.1 | 11.1 |

PC5 MPR results for 29 GHz with 120kHz SCS UL256QAM

|  |  |  |
| --- | --- | --- |
| Modulation | Companies | MPRWT, BWchannel ≤ 100/200 MHz |
|  | Inner RB allocations,Region 1 | Edge RB allocations |
| DFT-s-OFDM | 64 QAM |  | ≤ 5.0 | ≤ 5.5 |
|  | 256QAM | MediaTek(R4-2315559) | 9 | 9 |
|  |  | Qualcomm(R4-2315054) | 8 | 8.5 |
|  |  | Nokia (R4-2311665) | 7.3 |
|  |  | Average | 8.1 | 8.3 |
| CP-OFDM | 64 QAM |  | ≤ 7.5 | ≤ 7.5 |
|  | 256QAM | Nokia (R4-2315265) | 8.8 |
|  |  | MediaTek(R4-2315559) | 11.5 | 11.5 |
|  |  | Qualcomm(R4-2315054) | 10.5 | 10.5 |
|  |  | Average | 10.3 | 10.3 |

|  |  |  |
| --- | --- | --- |
| Modulation | Companies | MPRWT, BWchannel = 400 MHz |
|  | Inner RB allocations,Region 1 | Edge RB allocations |
| DFT-s-OFDM | 64 QAM |  | ≤ 6.5 | ≤ 6.5 |
|  | 256QAM | MediaTek(R4-2315559) | 10.5 | 10.5 |
|  |  | Nokia (R4-2311665) | 7.1 |
|  |  | Average | 8.8 |
| CP-OFDM | 64 QAM |  | ≤ 9 | ≤ 9 |
|  | 256QAM | Nokia (R4-2315265) | 8.9 |
|  |  | MediaTek(R4-2315559) | 13 | 13 |
|  |  | Average | 11 | 11 |

39GHz

PC1 MPR results for 39 GHz UL256QAM

|  |  |  |
| --- | --- | --- |
| Modulation | Companies | MPRWT (dB), BWchannel ≤ 100 MHz |
|  | Outer RB allocations | Inner RB allocations |
|  |  |  | Region 1 | Region 2 |
| DFT-s-OFDM | 64 QAM | - | ≤ 6.5 | ≤ 5.0 | ≤ 5.0 |
|  | 256QAM | LGE(R4-2315540) | 8.5 | 8.5 | 8 |
| CP-OFDM | 64 QAM | - | ≤ 7.5 | ≤ 7.5 | ≤ 7.5 |
|  | 256QAM | LGE(R4-2315540) | 11 | 11 | 10.5 |

|  |  |  |
| --- | --- | --- |
| Modulation | Companies | MPRWT (dB), BWchannel =400 MHz |
|  | Outer RB allocations | Inner RB allocations |
|  |  |  | Region 1 | Region 2 |
| DFT-s-OFDM | 64 QAM |  | ≤ 6.5 | ≤ 6.5 | ≤ 6.5 |
|  | 256QAM | LGE(R4-2315540) | 10.5 | 9.5 | 10 |
| CP-OFDM | 64 QAM |  | ≤ 9.0 | ≤ 9.0 | ≤ 9.0 |
|  | 256QAM | LGE(R4-2315540) | 13 | 12 | 12.5 |

**Issue 1-1-1: MRP requirements for PC1 of 29GHz**

* Proposals
	+ Option 1: The single CC MPR for PC1 in 256QAM operation shall not exceed that of 64QAM by more than 3 dB. (Qualcomm, Apple, Sony, Ericsson)
	+ Option 2: Average the MPR simulation results from different companies, for example 29GHz PC1

|  |  |  |
| --- | --- | --- |
| Modulation |  | MPRWT (dB), BWchannel ≤ 100/200 MHz |
|  | Outer RB allocations | Inner RB allocations |
|  |  | Region 1 | Region 2 |
| DFT-s-OFDM | 64 QAM | - | ≤ 6.5 | ≤ 5.0 | ≤ 5.0 |
|  | 256QAM | Average | 8.5 | 8.3 | 8.2 |
|  |  | Delta from 64QAM | 2 | 3.3 | 3.2 |
| CP-OFDM | 64 QAM | - | ≤ 7.5 | ≤ 7.5 | ≤ 7.5 |
|  | 256QAM | Average | 10.7 | 10.8 | 10.8 |
|  |  | Delta from 64QAM | 3.2 | 3.3 | 3.3 |

|  |  |  |
| --- | --- | --- |
| Modulation |  | MPRWT (dB), BWchannel =400 MHz |
|  | Outer RB allocations | Inner RB allocations |
|  |  |  | Region 1 | Region 2 |
| DFT-s-OFDM | 64 QAM | - | ≤ 6.5 | ≤ 6.5 | ≤ 6.5 |
|  | 256QAM | Average | 9 | 8.9 | 8.9 |
|  |  | Delta from 64QAM | 2.5 | 2.4 | 2.4 |
| CP-OFDM | 64 QAM | - | ≤ 9.0 | ≤ 9.0 | ≤ 9.0 |
|  | 256QAM | Average | 11.4 | 11.2 | 11.4 |
|  |  | Delta from 64QAM | 2.4 | 2.2 | 2.4 |

* + Option 3: Consider a common MPR is defined for all FR2 bands, and introduce a Δ value for 29GHz.
* Recommended WF
	+ The single CC MPR for PC1 in 256QAM operation shall larger 3dB than that of 64QAM.

LGE: For CP-OFDM the delta from 64QAM is above 3dB. How can we apply it?

Sony: when looking at the CP-OFDM, it is slightly larger than 3dB. We have very tight budget for coverage.

Vivo: 3dB is OK for 28GHz. For 39GHz, 3dB is not enough.

Qualcomm: we can see this will happen. But this is optional. It is better to have good requirements.

Apple: We are questioning 3dB gap. However, 3dB may need be proposed for FWA device type.

Mediatek: we have the similar view as Vivo.

Sony: to Vivo and Mediatek, we share the similar understanding as Qualcomm. Here we have concern on the link budget.

Huawei: Based on the companies’ proposals, there are good summaries in the table. Why do we not choose the averaged values from companies?

Ericsson: we do not need the separate requirement for above and below 30GHz.

Vivo: to Sony and Qualcomm, it is true that we expect the better performance for UL 256QAM. In the last meeting, we have already modified the assumption for I/Q imbalance.

Verizon: There is no battery issue for PC1.

Sony: to Vivo, our proposal is 3dB larger than the existing requirements, which is already compromise.

Qualcomm: This optional capability per band and limited to FWA device. We do not mandate UE to support it. It could be useful to agree 3dB rule as general to derive the MPR and it is UE burden to improve.

Verizon: We agree with Ericsson and Sony.

**Issue 1-1-2: MRP requirements for PC2 of 29GHz**

* Proposals
	+ Option 1: The single CC MPR for PC2 in 256QAM operation shall not exceed that of 64QAM by more than 3 dB.
	+ Option2: Average the MPR simulation results from different companies, for example 29GHz PC2:

|  |  |  |
| --- | --- | --- |
| * Modulation
 | Companies | MPRWT, BWchannel ≤ 100/200 MHz |
|  | Inner RB allocations,Region 1 | Edge RB allocations |
| DFT-s-OFDM | 64 QAM |  | ≤ 5.0 | ≤ 5.5 |
|  | 256QAM | Average | 8 | 8.2 |
|  |  | Delta from 64QAM | 3 | 2.7 |
| CP-OFDM | 64 QAM |  | ≤ 7.5 | ≤ 7.5 |
|  | 256QAM | Average | 10.3 | 10.3 |
|  |  | Delta from 64QAM | 2.8 | 2.8 |

|  |  |  |
| --- | --- | --- |
| Modulation | Companies | MPRWT, BWchannel =400 MHz |
|  | Inner RB allocations,Region 1 | Edge RB allocations |
| DFT-s-OFDM | 64 QAM |  | ≤ 6.5 | ≤ 6.5 |
|  | 256QAM | Average | 9.2 | 9.2 |
|  |  | Delta from 64QAM | 2.7 | 2.7 |
| CP-OFDM | 64 QAM |  | ≤ 9 | ≤ 9 |
|  | 256QAM | Average | 11.1 | 11.1 |
|  |  | Delta from 64QAM | 2.1 | 2.1 |

* Recommended WF
	+ The single CC MPR for PC2 in 256QAM operation can keep the same Delta value as PC1 from 64QAM.

**Issue 1-1-3: MRP requirements for PC5 of 29GHz**

* Proposals
	+ Option 1: The single CC MPR for PC5 in 256QAM operation shall not exceed that of 64QAM by more than 3 dB.
	+ Option2: Average the MPR simulation results from different companies, for example 29GHz PC5:

|  |  |  |
| --- | --- | --- |
| * Modulation
 |  | MPRWT, BWchannel ≤ 200 MHz |
|  | Inner RB allocations,Region 1 | Edge RB allocations |
| DFT-s-OFDM | 64 QAM |  | ≤ 5.0 | ≤ 5.5 |
|  | 256QAM | Average | 8.1 | 8.3 |
|  |  | Delta from 64QAM | 3.1 | 2.8 |
| CP-OFDM | 64 QAM |  | ≤ 7.5 | ≤ 7.5 |
|  | 256QAM | Average | 10.3 | 10.3 |
|  |  | Delta from 64QAM | 2.8 | 2.8 |

|  |  |  |
| --- | --- | --- |
| Modulation |  | MPRWT, BWchannel = 400 MHz |
|  | Inner RB allocations,Region 1 | Edge RB allocations |
| DFT-s-OFDM | 64 QAM |  | ≤ 6.5 | ≤ 6.5 |
|  | 256QAM | Average | 8.8 | 8.8 |
|  |  | Delta from 64QAM | 2.3 | 2.3 |
| CP-OFDM | 64 QAM |  | ≤ 9 | ≤ 9 |
|  | 256QAM | Average | 11 | 11 |
|  |  | Delta from 64QAM | 2 | 2 |

* Recommended WF
	+ The single CC MPR for PC5 in 256QAM operation can keep the same Delta value as PC1 from 64QAM.

**Issue 1-1-3: MRP requirements for 39GHz**

* Proposals
	+ Option 1: Further discuss the phase noise model at 39 GHz before deciding how to define the MPR requirements for 39GHz.
	+ Option 2: Using the same MPR values for 39 GHz and 28 GHz.
	+ Option 3: Consider a common MPR is defined for all FR2 bands, and introduce a band-specific Δ value for 39GHz frequency band.
* Recommended WF
	+ TBA

**Issue 1-1-4: MRP requirements for intra-band CA**

* Proposals
	+ Option 1: Intra-band CA MPRs for both, contig. and NC, and forPC1/2/5 in 256QAM operation are increased from their respective 64QAM values by 3 dB.
	+ Option2: Others.
* Recommended WF
	+ TBA

**Issue 1-1-5: MRP requirements for inter-band CA**

* Proposals
	+ Option 1: No special treatment is necessary for inter-band CA MPRs for UL256QAM.
	+ Option2: Others.
* Recommended WF
	+ TBA

Agreement: No special treatment is necessary for inter-band CA MPRs for UL256QAM

**Issue 1-1-6: MRP requirements for MIMO**

* Proposals
	+ Option 1: No special treatment is necessary for UL MIMO MPRs for UL256QAM.
	+ Option2: Others.
* Recommended WF
	+ TBA

Agreement: No special treatment is necessary for UL MIMO MPRs for UL256QAM.

### Sub-topic 1-2 Other

*Sub-topic description*

*Open issues and candidate options before meeting:*

**Issue 1-2-1: The feasibility of PC3**

* Proposals
	+ Option 1: Remove PC3 from the object of FR2-1 UL 256QAM in the WID.
	+ Option 2: The following items are proposed as a package
		- Shift completion of PC3 256QAM to Rel-19 and take the time to discuss the specific challenges on handhelds.
		- Evaluate the impact of 4% Tx EVM on the network performance and PA design challenges. Rx EVM at base station remains at 3.5%.
		- A max delta of 3dB between 64QAM and 256QAM can be acceptable for PC1, PC2 and PC5 if this agreement is not treated as a precedence for PC3 discussion.
	+ Option 3: Others
* Recommended WF
	+ TBA

Apple: Option 2 comes from us. We should set the precedence for PC3 even if we agree 3dB for PC1. The requirements with 3dB gap is too tighten for PC3.

Sony: we need high level agreement first.

Vivo: we support option 1. We do not have time to do feasibility study. For option 2, it is not proper way to discuss it. It is RAN plenary issue.

Xiaomi: Prefer option 1. How to deal with PC3 in Rel-19 is separate discussion.

ZTE: in the previous meeting, we provided feasibility study for PC3. For PC3, there is some benefit. We are fine not to consider PC3 in Rel-18.

Vivo: to ZTE, the link level simulation does not consider MPR. If we consider power reduction in the link level simulation, I doubt if there is benefit.

Nokia: it is too late to complete PC3 in Rel-18.

Agreement: RAN4 suggests to remove PC3 from the object of FR2-1 UL 256QAM in the WID

**Issue 1-2-2: how to capture no PTRS in EVM test**

* Proposals
	+ Option 1: Send a LS to RAN5 to inform that PTRS is not configured for FR2 256QAM related test.
	+ Option 2: Only add a note in RAN4 Spec to clarify.
* Recommended WF
	+ TBA

Xiaomi: we do not need special handling PTRS for 256QAM. It should be the same thing for 64QAM. In RAN4 spec, there is EVM testing schedule, there is not PTRS configuration.

Qualcomm: we agree with Xiaomi.

Vivo: We are OK to withdraw LS.

# Topic #2: TP and CR

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2315435**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_108bis/Docs/R4-2315435.zip) | Xiaomi | TP for TR 38.891 to capture the simulation assumptions for phase noise profiles evaluation and MPR simulation results from different companies. |
| [**R4-2315436**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_108bis/Docs/R4-2315436.zip) | Xiaomi | Draft  |
| [**R4-2315539**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_108bis/Docs/R4-2315539.zip) | LG Electronics France | Draft CR for Rel-18 38.101-2 to specify the EVM with limit MCS for UL256QAM |
| [**R4-2315810**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_108bis/Docs/R4-2315810.zip) | vivo | Draft CR for FR2-1 UL 256QAM MPR |

## Open issues summary

*Before Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 2-1 TP and CR

*Sub-topic description:*

*Open issues and candidate options before meeting:*

**Issue2-1-1: Approved TP in R4-2315435**

* Proposals
	+ Option 1: Yes
	+ Option 2: Modification is needed
* Recommended WF
	+ TBA

**Issue 2-1-2: How to capture MPR values for PC2/5**

* Proposals
	+ Option1: Capture into the MPR table of PC3 and clarify that MPRs for 256QAM are applicable for power class 2 and 5 only in the note, as below:

|  |  |
| --- | --- |
| Modulation | MPRWT, BWchannel |
|  | Inner RB allocations,Region 1 | Edge RB allocations |
| DFT-s-OFDM | Pi/2 BPSK | 0.0 | ≤ 2.0 |
|  | QPSK | 0.0 | ≤ 2.0 |
|  | 16 QAM | ≤ 3.0 | ≤ 3.5 |
|  | 64 QAM | ≤ 5.0 | ≤ 5.5 |
|  | 256 QAM | TBD | TBD |
| CP-OFDM | QPSK | ≤ 3.5 | ≤ 4.0 |
|  | 16 QAM | ≤ 5.0 | ≤ 5.0 |
|  | 64 QAM | ≤ 7.5 | ≤ 7.5 |
|  | 256 QAM | TBD | TBD |
| Note 1: MPRs for 256QAM are applicable for power class 2 and 5 only. |

* + Option2: introduce a new table into related clause of PC2 6.2.2.2 for 256QAM:

|  |  |
| --- | --- |
| Modulation | MPRWT, BWchannel |
|  | Inner RB allocations,Region 1 | Edge RB allocations |
| DFT-s-OFDM | 256 QAM | TBD | TBD |
| CP-OFDM | 256 QAM | TBD | TBD |

* Recommended WF
	+ TBA

**Issue2-1-1: How to specify the EVM with limit MCS for UL256QAM**

* Proposals
	+ Option 1: introduce a note to limit MCS

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Unit | Average EVM level | Reference signal EVM level |
| Pi/2 BPSK  | % | 30.0 | 30.0 |
| QPSK  | % | 17.5 | 17.5 |
| 16 QAM  | % | 12.5 | 12.5 |
| 64 QAM  | % | 8.0 | 8.0 |
| 256 QAM | % | 3.51 | 3.51 |
| NOTE 1: It is applicable for MCS#20,#21,#22 and #23 in band n257, n258 and n261 and MCS#20, #21 and #22 in band n259 and n260 as specified in TS38.214 Table 5.1.3.1-2. |

* + Option 2: No need limit in RAN4 Spec.
* Recommended WF
	+ TBA